

---

# **Study on the Effect of Varying Fuel Composition on Fuel Supplied to Cummins and Detroit Diesel Gas Engines**

For:

Mike Landau, Southern California Gas

By:

James P. Chiu, Southwest Research Institute



# Low Methane Number Gas

---

- Major effect is reduced knock resistance
  - Can destroy an engine
- Other Effects
  - Change in flame speed
    - Effectively advance ignition timing
  - Change in volume energy density
    - Effects volume flow metering devices



# Gas Properties

Property	CARB Gas (for certification)	Richest Case Gas (SoCalGas Rule 30)
Methane	90.45	84.00
Ethane	4.02	8.10
Propane	2.01	6.30
Butane	0.00	0.00
N2	3.52	1.60
CO2	0.00	0.00
AVL MN	81.3	67.8
CARB MN	89.0	70.9
BTU/SCF	1035	1150
Wobbe Index	1323	1412



# Engines

Engine	Model	Fuel Induction	Fuel Control	Years
Cummins L10G	Phase 1	Carburetor	Open Loop	1991-1993
Cummins L10G	Phase 2	Carburetor	Open Loop	1994-1995
Cummins L10G	Phase 3	Fuel Valve/Mixer	Closed Loop	1996-1999
Cummins B5.9G		Fuel Valve/Mixer	Closed Loop	-2001
Cummins C8.3G		Fuel Valve/Mixer	Closed Loop	-2002
Detroit Diesel	Series 50G	Carburetor	Open Loop	Before Oct 1998
Detroit Diesel	Series 50G	Fuel Valve/Mixer	Closed Loop	Oct 1998 – Sep 2002
Detroit Diesel	Series 50G	Fuel Valve/Mixer	Closed Loop	After Sep 2002



# Open Loop Fueling

---

- Engines
  - Cummins L10 Phase 1
  - Cummins L10 Phase 2
  - DDC Series 50G (Before Sep 1998)
- These engine will not operate correctly on the richest case gas



# Open Loop Fueling

---

- Upgrade engine with closed loop fueling and knock detection
  - Aftermarket kit available for the L10 engines
  - ~\$150,000 one time development cost
  - ~\$12,000 per engine for upgrade
- Replace engine
  - ~\$75,000 one time cost
  - ~\$35,000 per vehicle for engine replacement



# Closed Loop Fueling

---

- Engines
  - Cummins L10 Phase 3
  - Cummins B5.9G
  - Cummins C8.3G
- Some engines may be able to run on the richest case gas, but there is little to no margin for knock
- SwRI does not recommend operating any of these engine on the richest case gas



# Closed Loop Fueling

---

- Upgrade engine with knock detection
  - ~\$200,000 one time development cost
  - ~\$1300 per engine cost
- Upgrade engines with a manufacturers kit
  - Cummins B5.9G and C8.3 G can be upgraded to the plus version at a cost of ~\$12,000 per engine





# Closed Loop Fueling w/knock detection

---

- Engines
  - DDC Series 50G (Sep 1998 and Oct 2002)
  - DDC Series 50G (After Sep 2002)
- This engine could operate on the richest case gas
- Manufacturer's fuel specification should be updated to reflect engine capabilities



---

# The End

